FINAL REPORT

LIMITED ENERGY STUDY
GEODSS FACILITY

WHITE SANDS MISSILE RANGE,
NEW MEXICO

Prepared for

U.S. ARMY ENGINEER DISTRICT, MOBILE
MOBILE, ALABAMA

Under

U.S. ARMY ENGINEER DISTRICT, MOBILE
INDEFINITE DELIVERY A-E CONTRACT
CONTRACT NO. DACA01-94-D-0033
DELIVERY ORDER NO. 0008

EMC ENGINEERS, INC.

DENVER, COLORADO
ATLANTA, GEORGIA

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By

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This report has been prepared at the request of the client, and the observations, conclusions, and recommendations contained herein constitute the opinions of E M C Engineers, Inc. In preparing this report, EMC has relied on some information supplied by the client, the client's employees, and others which we gratefully acknowledge. Because no warranties were given with this source of information, E M C Engineers, Inc. cannot make certification or give assurances except as explicitly defined in this report.

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LIST OF ABBREVIATIONS

ACC	-	air cooled condenser
ACCU	-	air cooled condensing unit
AHU	-	air handling unit
Btu	-	British thermal unit
CHLR	-	chiller
CNW	-	condenser water
CNWR	-	condenser water return
CNWS	-	condenser water supply
COE	-	Corps of Engineers
CRUs	-	computer room units
CV	-	converter
CW	-	chilled water
CWP	-	chilled water pump
CWR	-	chilled water return
CWS	-	chilled water supply
DOE2.1d	-	Computer program used for calculating building hour energy use.
DTW	-	dual temperature water
DTWP	-	dual temperature water pump
ECO	-	Energy Conservation Opportunity
EMC	-	E M C Engineers, Inc.
F	-	fahrenheit
FEMP	-	Federal Energy Management Program
ft	-	foot, feet
ft^2	-	square feet
gal	-	gallons
gpm	-	gallons per minute
hp	-	horsepower
hr	-	hour
HRU	-	heat recovery unit

HW	-	hot water
HWP	-	hot water pump
HWR	-	hot water return
HWS	-	hot water supply
H&V	-	heating and ventilating
IR	-	infrared radiant
kW	-	kilowatt, one thousand watts
kWh	-	kilowatt-hours, one thousand watt-hours
lb/hr	-	pounds per hour
LCCA	-	life cycle cost analysis
MAU	-	make-up air unit
MBtu	-	million British thermal unit
MZ	-	multizone
O&M	-	operation and maintenance
OA	-	outside air
psia	-	pounds per square inch absolute
psig	-	pounds per square inch gage
RA	-	return air
RAD	-	radiation heating system
RAF	-	return air fan
rpm	-	revolutions per minute
SOW	-	scope of work
sq ft	-	square foot
STM	-	steam
SZ	-	single zone
temp.	-	temperature
UH	-	unit heater
UMCS	-	utility monitoring and control system
VAV	-	variable air volume
VSD	-	variable speed drive
WAC	-	window air conditioner

WSMR	-	White Sands Missile Range
yr	-	year(s)

EXECUTIVE SUMMARY

AUTHORITY

This study was performed and this report prepared under Contract No. DACA01-94-D-0033, Delivery Order No. 8. The delivery order was issued by U.S. Army Engineer District, Mobile, to E M C Engineers, Inc. on 8 May 1995.

PURPOSE

The purpose of this study is to identify and evaluate Energy Conservation Opportunities (ECOs), to determine their energy savings potential and economic feasibility, and to document results for possible future funding.

BUILDING AND HVAC DATA

The Ground Based Electro-Optical Deep Space Surveillance (GEODSS) Facility, Building 34568, is a windowless, concrete block structure approximately 10,000 square feet. The building is located on the northern end of the White Sands Missile Range in central New Mexico. The building consists of a large central computer room with perimeter offices. Concrete towers at three corners of the building are topped with telescopes in movable domes. The building is occupied 24 hours per day. The building is conditioned by the following HVAC and auxiliary systems:

- The computer room is conditioned by three Computer Room Units (CRUs) each rated at 12,000 cfm. The CRUs are located within the computer room and distribute supply air via a perforated floor. Each CRU contains a fan, chilled water coil, electric reheat coil, and a humidifier. Room temperature is maintained in the 70° to 72°F range and relative humidity in the 35% to 50% range.

- The offices and hallways are conditioned by a single-zone HVAC system consisting of a fan supplying 4,770 cfm, a chilled water cooling coil, and an electric duct heater. Outside air is specified at 26% of supply air. Room temperature is maintained in the 70° to 72°F range.

- A small conference room adjacent to the offices is served by a small dedicated AHU containing a chilled water cooling coil.

- Each telescope tower is served by a dedicated 2,000 cfm AHU. Each AHU is a once-through system in which outside air is drawn in, cooled by a chilled water cooling coil, ducted to the tower, and expelled through openings in the dome. Each room thermostat is set at 40°F, but the HVAC system is incapable of reaching this

temperature, given the 45°F chilled water temperature serving the cooling coil. It is desired to keep the telescope as cool as possible to minimize stabilization time when the telescope is exposed to the cold night sky. The AHUs serving the towers are operated from mid April to mid November. The AHUs are turned off in the winter.

- All eight AHUs in the building are supplied with chilled water from the central chilled water system. The chilled water system consists of two 36-ton chillers coupled to two air-cooled condensers. Chilled water is supplied to HVAC cooling coils via a primary/secondary pumping arrangement.

- Lighting is provided mainly by recessed fluorescent fixtures each containing two standard 40 watt T-12 fluorescent lamps powered by standard magnetic coil ballasts. Offices and hallways have been extensively delamped and most offices are equipped with occupancy sensors.

- Electric power is supplied to the computer room and electronic equipment associated with the telescopes through a rotating Uninterrupted Power Supply (UPS) system. The UPS system consists of a 120 volt/150 kW generator coupled to a large flywheel turned by a 250 horsepower motor. The flywheel will provide about 17 seconds of uninterrupted power, sufficient time for the emergency diesel-electric generator to come on-line in the event of an interruption to commercial power. Power to the motor was measured during the field survey. The motor was drawing about 85 amps at 281 volts with a power factor of about 0.45.

HISTORICAL ENERGY USE

Electric power is supplied to the GEODSS Facility by Socorro Electric. The facility is billed for electricity by the White Sands Missile Range at a rate of $0.0821 per kWh. There is no demand charge.

The facility is metered by a dedicated electric meter. This meter was calibrated by ZIA Electrical Products as part of this study. The meter was found to be accurate within 1.0% in its "as found" condition.

The diesel-electric generator provides backup power for the facility and is used quite often due to poor reliability of commercial service and the frequency of electrical storms.

Average site energy consumption was based on four years of utility data and is presented in Table ES-1.

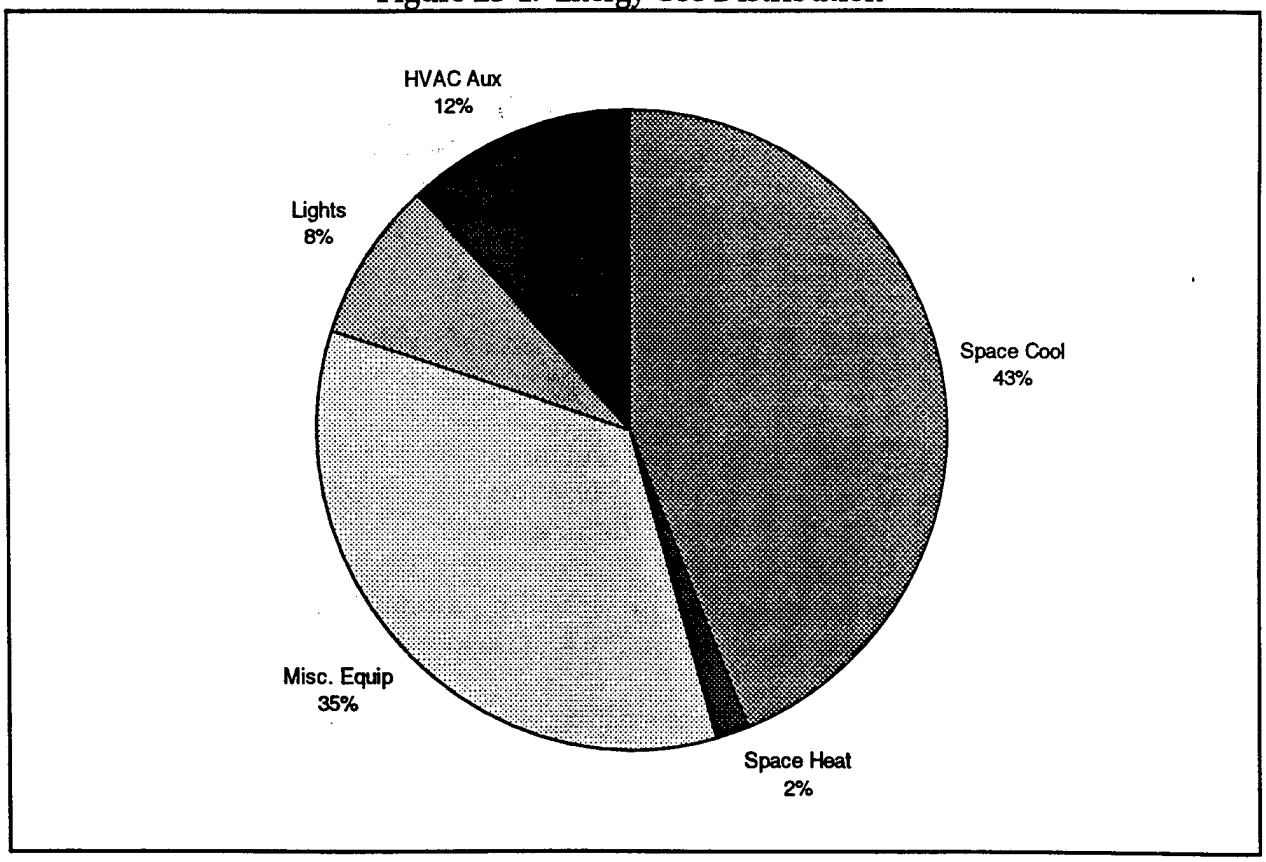
Table ES-1. Historical Energy Consumption Data

Energy Type	Annual Energy Use	Unit Energy Cost	Annual Energy Cost	Annual MBtu
Electricity	1036 MWh	$0.0821/kWh	$85,056	3536
Diesel Fuel	5932 gal	$1.03/gal	$6,110	823

BASELINE ENERGY USE

The DOE2.1d Building Energy Simulation Program was used to model the building using TMY weather for Truth or Consequences, New Mexico. Figure ES-1 presents the electric energy use distribution. Miscellaneous equipment consumes about 35% of the annual energy used at the facility. Miscellaneous equipment includes computers, office equipment, electronic equipment, cameras, and the air compressors. Space cooling consumes about 43% of the annual energy. Fans, pumps, and lighting consumes the remaining 20%. Space heating consumes less than 2% of the annual energy.

Figure ES-1. Energy Use Distribution



ENERGY CONSERVATION OPPORTUNITIES (ECOs)

The following is a brief summary of the ECOs investigated.

ECO 1: **Albedo Modification:** Repainting the exterior walls white and placing white gravel on the roof to decrease solar heat gain was found not to be cost-effective. Energy savings are minimal due to good insulation.

ECO 2: **Roof Insulation:** The existing roof insulation thickness of 4 inches is greater than the optimum insulation thickness of 2 inches.

ECO 3: **Low-Emissivity Roof Coating:** A low-emissivity coating applied to the underneath side of the roof deck was found not to be cost effective. Energy savings are minimal due to good insulation.

ECO 4: **T-8 Fluorescent Lamps:** Installing high efficiency lighting and electronic ballasts were found to be cost effective.

ECO 5: **Vortex Tube Cooling:** Cooling for the telescope cameras was found to consume a relatively large amount of energy. Correction is beyond the scope of this project.

ECO 6: **High-Efficiency Motors:** Replacing one of the existing HVAC fan motors with a more efficient motor was found to be cost effective.

ECO 7: **UPS System:** The existing system was found to be very inefficient. Two cost effective modifications are recommended.

ECO 8: **Chiller Replacement:** Replacing the existing chillers was found to be cost effective.

ECO 9: **Recirculate Air in Towers:** Recirculating room air and reducing the outside airflow rate in the camera towers was found to be cost effective. The HVAC systems are currently 100% outside air systems.

ECO 10: **Turn Off Office AHU at Night:** Installing a time clock to turn off the AHU serving the office areas in the building at night was found to be cost effective.

ECO 11: **Propane Heat:** Replacing the existing electric duct heaters with propane-fired duct furnaces was found not to be cost effective.

ECO 12: **Economizer:** Installing an economizer on AHU-2 serving the office was found not to be cost effective.

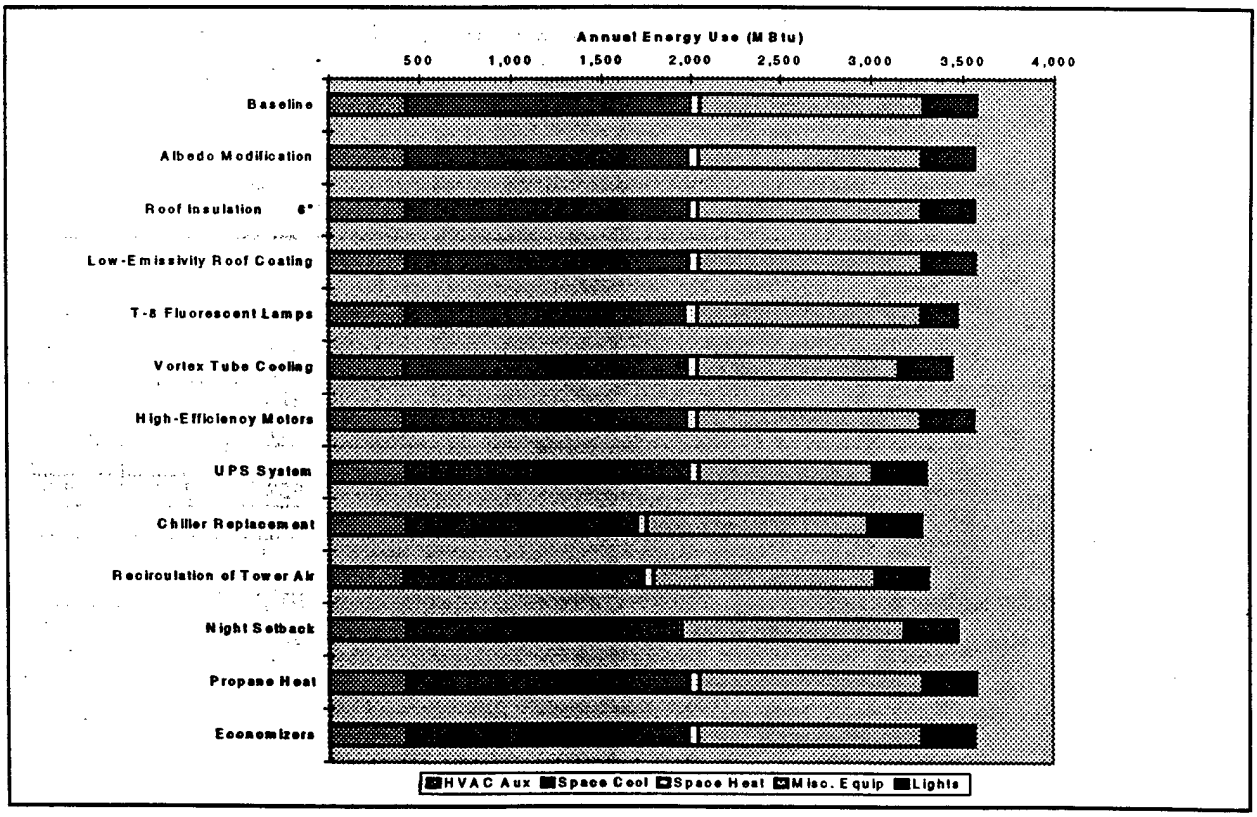
Table ES-2 on the following page presents the results of the analysis for each ECO.

Table ES-2. Summary of Results

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
1	Albedo Modification	1,532	126	0	N/A	N/A	N/A
2	Roof Insulation 6"	1,939	159	0	N/A	N/A	N/A
3	Low-Emissivity Roof Coating	900	74	0	N/A	N/A	N/A
4	T-8 Fluorescent Lamps	29,455	2,418	47	12,429	2.38	5.0
5	Vortex Tube Cooling	38,441	3,156	0	N/A	N/A	N/A
6	High-Efficiency Motors	2,197	180	0	1,753	1.55	9.7
7	UPS System	89,454	7,344	0	22,874	4.85	3.1
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.3
9	Recirculation of Tower Air	74,518	6,118	0	22,767	4.05	3.7
10	Turn Off AHU at Night	48,210	3,958	0	420	80.86	0.1
11	Propane Heat	1,199	65	0	11,182	0.08	171.7
12	Economizers	967	79	0	4,096	0.29	51.6

A graphical representation of the annual energy use for the baseline model and each of the ECOs is presented in Figure ES-2 below.

Figure ES-2. Baseline Energy Use Vs. Recommended ECO Modifications



RECOMMENDATIONS

The following ECOs are recommended for implementation.

Table ES-3. Summary of Recommended ECOs

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
10	Turn Off AHU at Night	48,210	3,958	0	420	80.86	0.09
7	UPS System	89,454	7,344	0	22,874	4.85	3.11
9	Recirculation of Tower Air	74,518	6,118	47	22,767	4.05	3.72
4	T-8 Fluorescent Lamps	29,455	2,418	0	12,429	2.38	5.04
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.30
6	High Efficiency Motors	2,197	180	0	1,753	1.55	9.72
	Overall Savings	**280,029**	**22,990**	**47**	**101,292**	**N/A**	**4.41**

The overall savings takes into account the synergistic effects of multiple ECOs. The total annual energy cost savings for combined ECOs is $22,990 per year with a resulting simple payback of 4.4 years. The combined ECOs annual energy savings is 280,029 kWh per year, 27% of the present annual energy use.

To qualify for FEMP funding, ECOs must have an SIR greater than 1.25 and a simple economic payback less than 10 years. The following ECOs are recommended for funding as a Federal Energy Management Program (FEMP) project.

Table ES-4. Summary of ECOs Recommended for FEMP Funding

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
7	UPS System	89,454	7,344	0	22,874	4.85	3.11
9	Recirculation of Tower Air	74,518	6,118	0	22,767	4.05	3.72
4	T-8 Fluorescent Lamps	29,455	2,418	47	12,429	2.38	5.04
8	Chiller Replacement	85,453	7,016	0	99,539	2.01	8.30
	Combined Savings	252,877	20,761	47	157,609	2.74	5.7

The combined savings of these ECOs with synergistic effects taken into account is $20,761 per year with a resulting SIR of 2.74 and a simple payback of 5.7 years.

863 MBTU/yr

20.808 K$/yr

The following ECOs are recommended for in-house implementation by the GEODSS maintenance staff.

Table ES-5. Summary of ECOs Recommended for In-House Implementation

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
10	Turn Off AHU at Night	48,210	3,958	0	420	80.86	0.09
6	High-Efficiency Motors	2,197	180	0	1,753	1.55	9.72

The following ECOs are recommended for implementation with the installation of the new computer system, in about two years.

Table ES-6. Recommended ECO Upgrades with Computer Renovation

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
5	Vortex Tube Cooling	38,441	3,156	0	N/A	N/A	N/A

The following ECOs were not found to be cost effective:

Table ES-7. ECOs Not Recommended

ECO #	ECO Description	Annual Electric Energy Savings (kWh)	Annual Energy Cost Savings ($)	Annual Maintenance Cost Savings ($)	Total Investment Costs ($)	SIR	Simple Payback (yrs)
1	Albedo Modification	1,532	126	0	N/A	N/A	N/A
2	Roof Insulation 6"	1,939	159	0	N/A	N/A	N/A
3	Low-Emissivity Roof Coating	900	74	0	N/A	N/A	N/A
11	Propane Heat	1,199	65	0	11,182	0.08	171.70
12	Economizers	967	79	0	4,096	0.29	51.60